ALIST Issues and Approach

April 16, 2002

M. Ulrickson
ALPS Meeting
La Jolla, CA

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for the United States Department of Energy under contract DE-AC04-94AL85000.

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Outline

- Meeting with the NSTX Team March 26, 2002
- PMI Related Action Items
- Discussion Topics

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Topics Discussed

- Bell, Ono, Blanchard, Raftopoulos, Mansfield, Kaita, Peng, Schmidt, Majeski, Zakharov, Timberlake, Mueller
- Following meeting with Hawryluk and Goldston
- Recent results and status of the R&D on liquid surfaces were discussed
- Status and needs of NSTX Project discussed
- Results of CDX-U experiments with the tray limiter were discussed

NSTX Status

- Early in experimental program
  - Still inductive drive for current
  - High beta operation still short duration
  - Incomplete database and analysis of particle balance and control needs
- Synergy between NSTX and Liquid Module
  - Module encourages more NSTX data analysis
  - Module funding and NSTX research program are consistent

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MHD Stability of Flowing Liquid

- Self-consistent means of introducing flowing liquid metal into plasma simulation codes to determine the effect on equilibrium
- Resistive MHD code to determine the stability of plasmas surrounded by liquid metal walls

Code Status

- Tokamak Simulation Code (TSC) has difficulties
  - Awkward user interface
  - Calculation of boundary conditions “hard coded” so that space between plasma and wall cannot be filled with liquid
- NOVA-W resistive wall mode code no longer running
- Alternatives
  - Zakharov equilibrium and stability code (ESC)
  - Kotschenreuther resistive MHD code (WALLCODE)

Schedule Issues

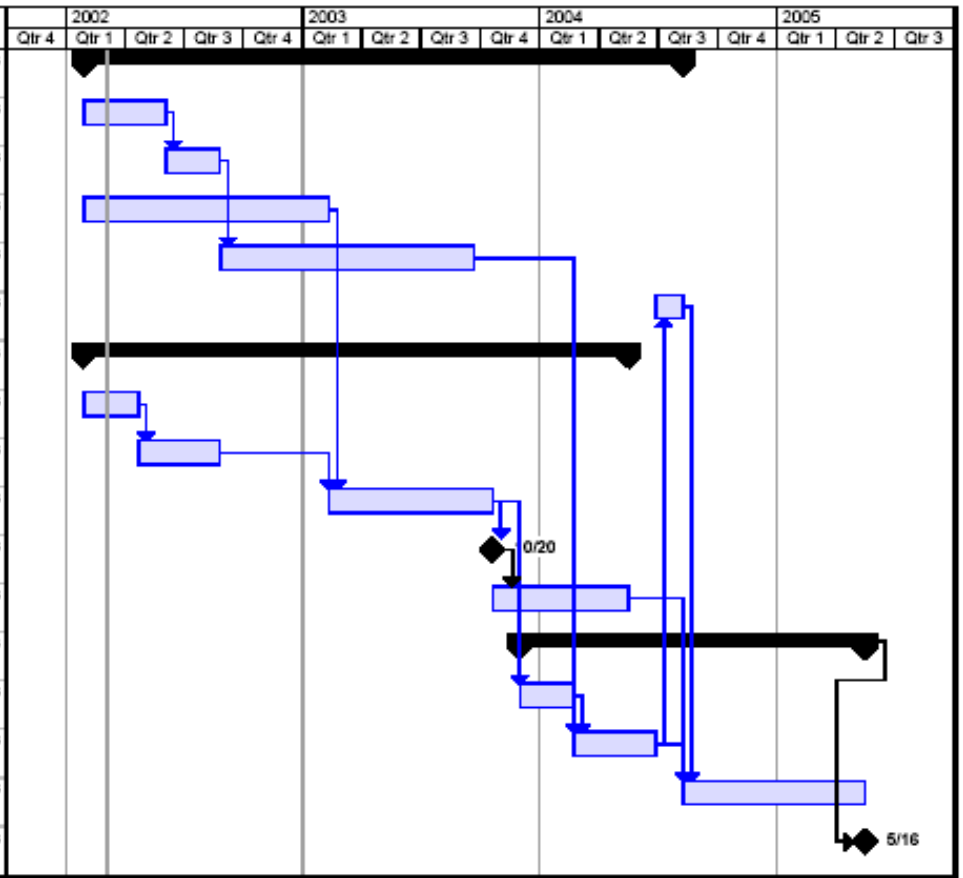
- Based on the release of the President's budget and the VLT budget discussions, it is evident that there will be only a modest increase (~4%) in funding for PFC technology in FY03.
- This will provide an additional year for basic research on MHD, heat removal, examination of options, and similar things.
- The tokamak programs are scheduled to receive a substantial increase in operating funds in FY03.
- The added funds will allow more physics operation.

Schedule Issues

- The convergence of these two issues means that the key decision point on proceeding with a liquid surface module is now early FY04 for NSTX
- The C-Mod schedule is more uncertain because they have new physics options available because of the added funds

ALIST Schedule for NSTX (3/02)

ID	Task Name	Duration
1	Flowing Liquid Research	660 days
2	MHD Studies	90 days
3	Heat Flux Testing	60 days
4	MHD Modeling of Experiments	270 days
5	Phase II Experiments and Modeling	280 days
6	Test prototype module	30 days
7	Flowing Liquids Module Design	600 days
8	Preconceptual design	60 days
9	Conceptual Design	90 days
10	Preliminary Design	180 days
11	Decision to Proceed	0 days
12	Final Design	150 days
13	Module Fabrication	380 days
14	Select fabricator	60 days
15	Manufacture prototypes	90 days
16	Manufacture final module	200 days
17	Ready for installation	0 days



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Plasma Edge Modeling

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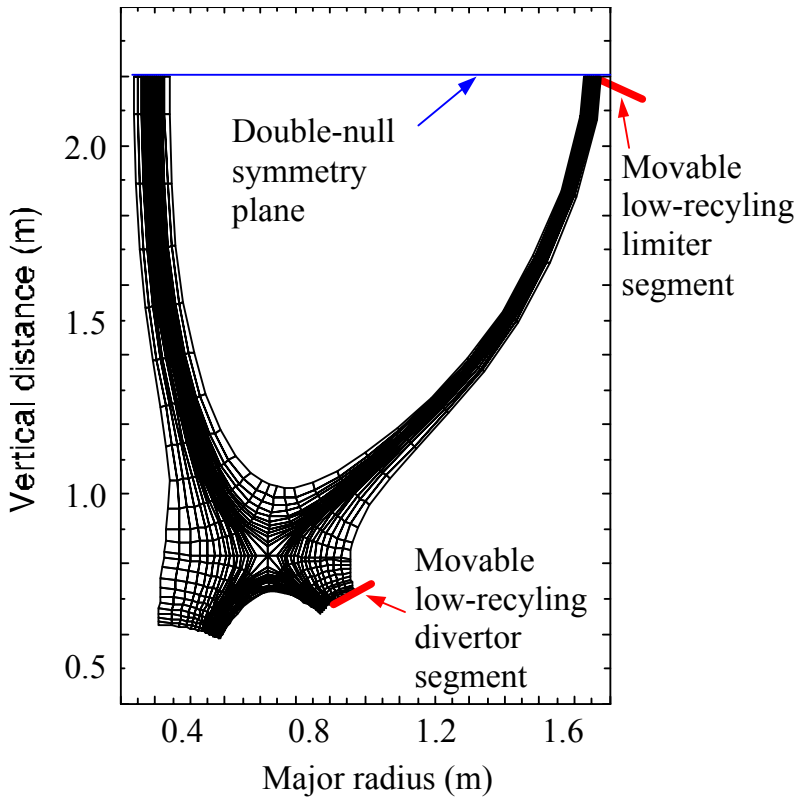
UEDGE Modeling of Plasma Edge



- **Regions having low recycling were placed either near the mid-plane or in the divertor.**
- **The position of the plates determined how many particles were pumped.**
- **The results for the divertor plate are shown on the subsequent slides.**
- **Tom Rognlien, LLNL**

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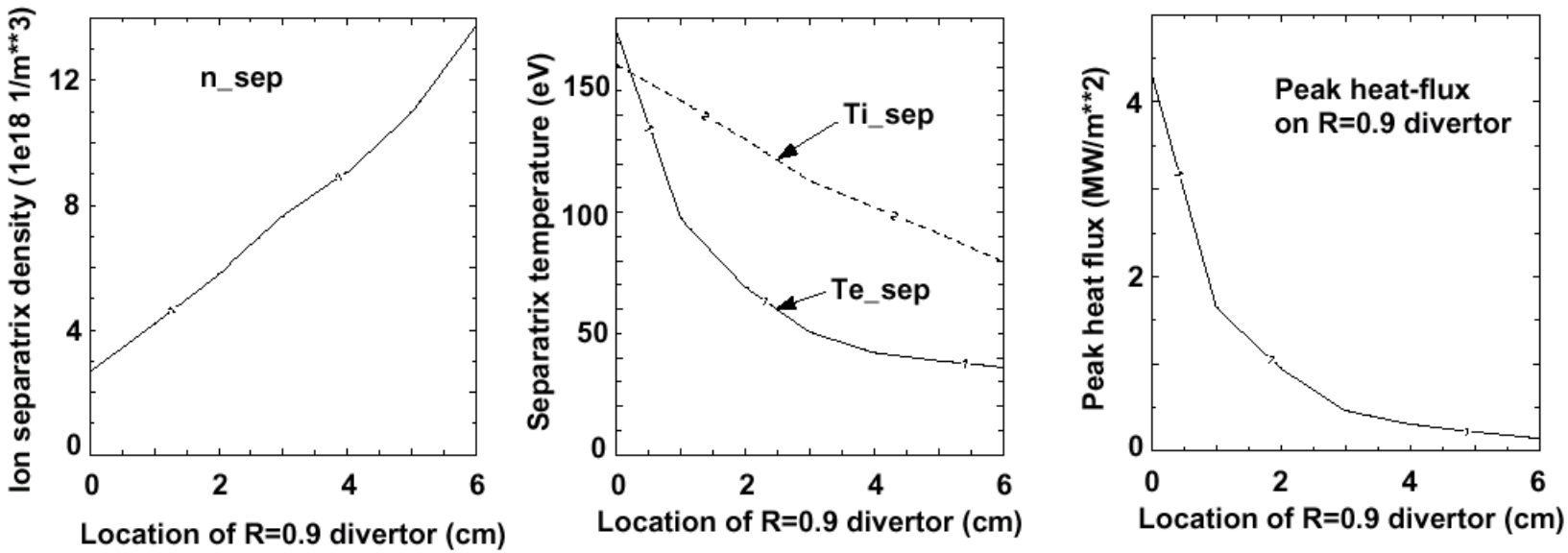
UEDGE Modeling Results (LLNL)



- Pumping increases edge temperature
- Pumping decreases edge density
- Divertor heat flux increases with pumping

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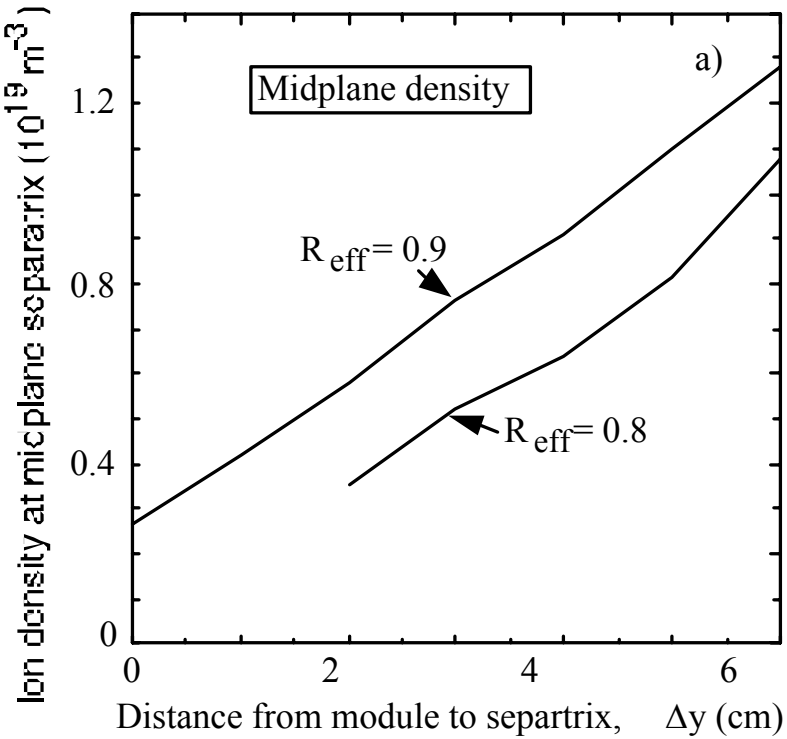
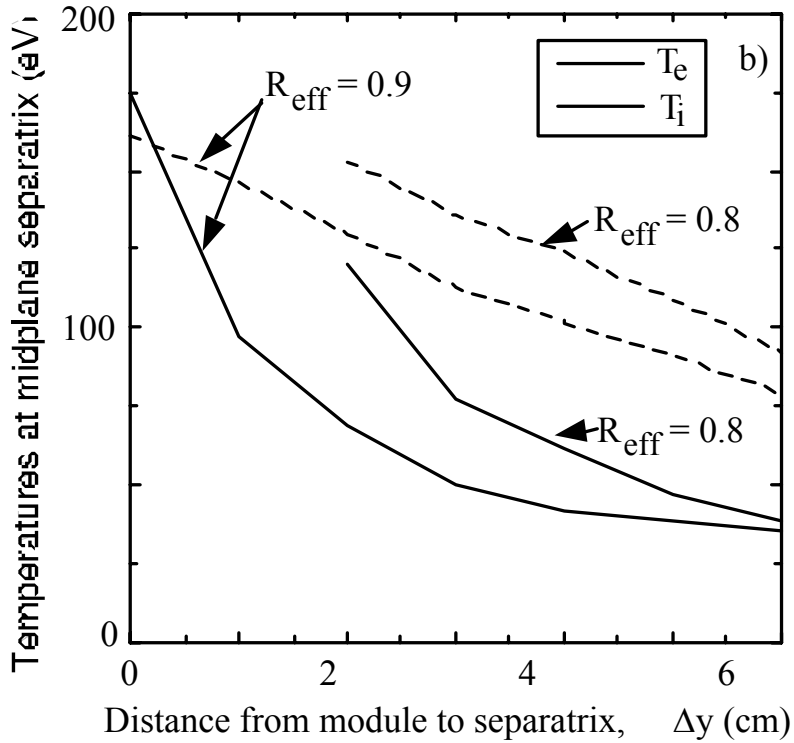
UEDGE Modeling Results (LLNL)





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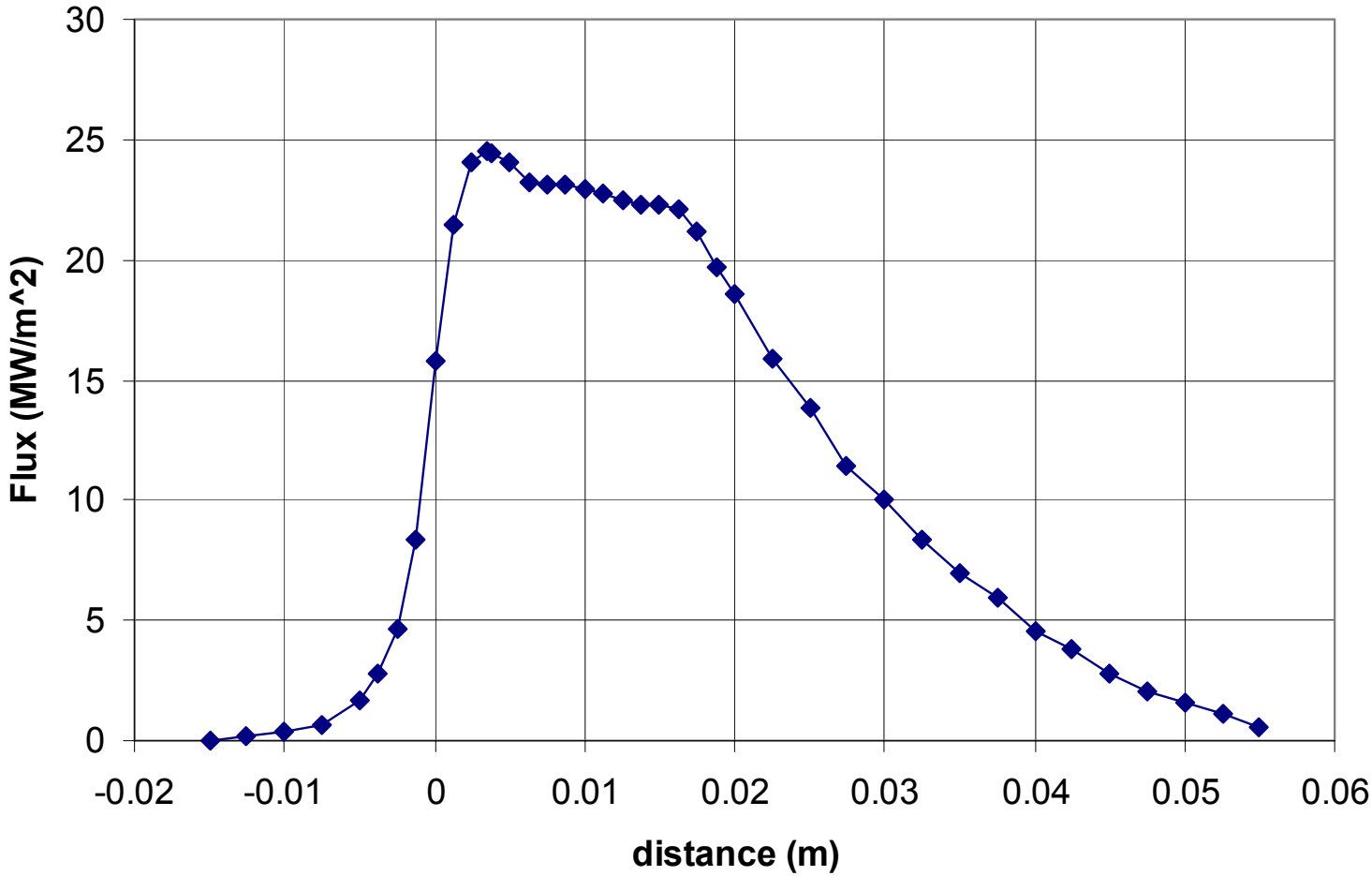
NSTX Heat Load Cases

- Tom Rognlein has supplied UEDGE output for low power and high power cases for NSTX plasmas
- The heat flux profiles are shown on the next slides
- These heat loads have been imposed on a liquid Li surface flowing at 10 m/s.
- The resulting temperature profiles have been supplied to Jeff Brooks for erosion and sheath effect modeling

High Power Case



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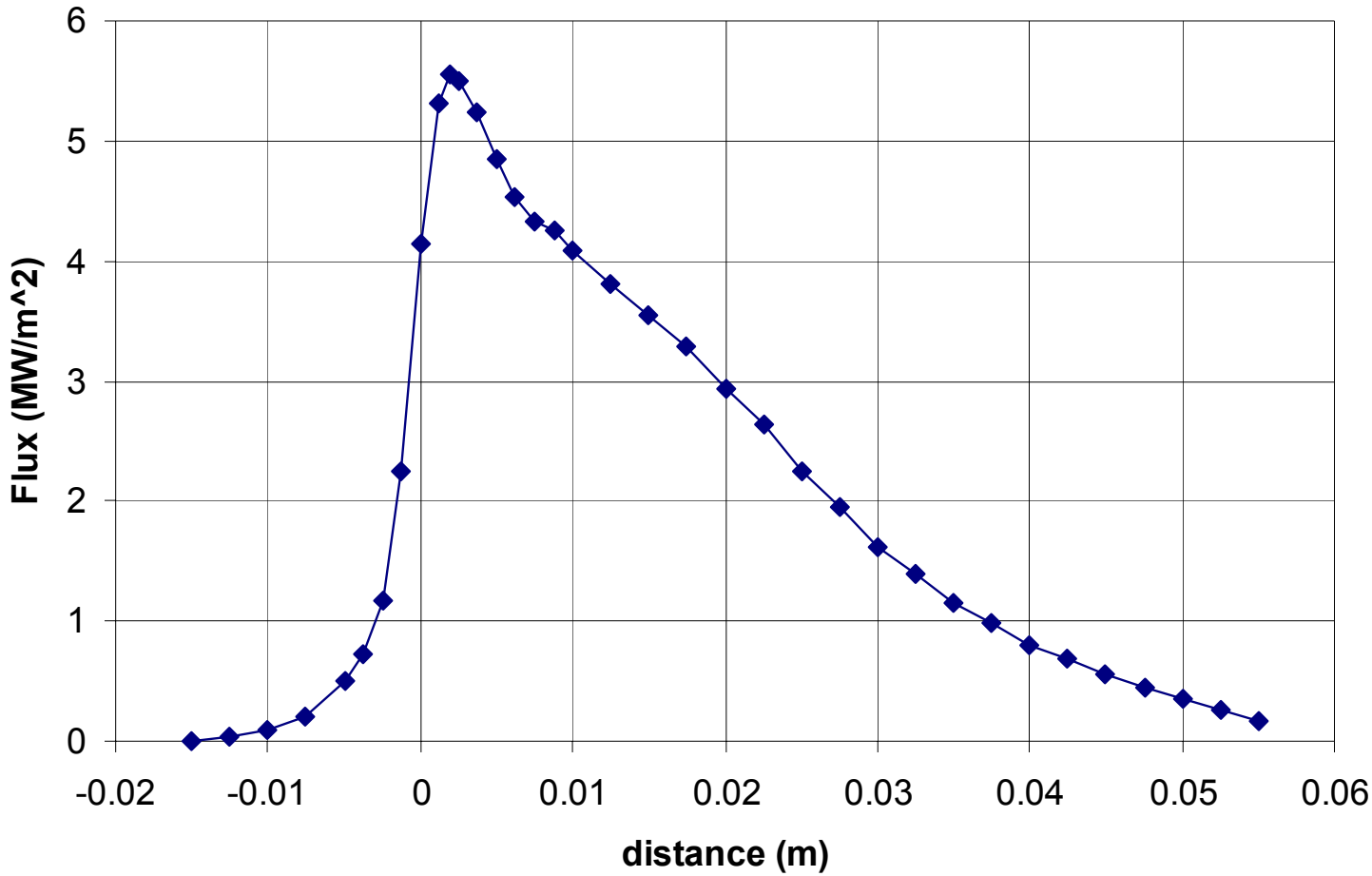
Low Power Case



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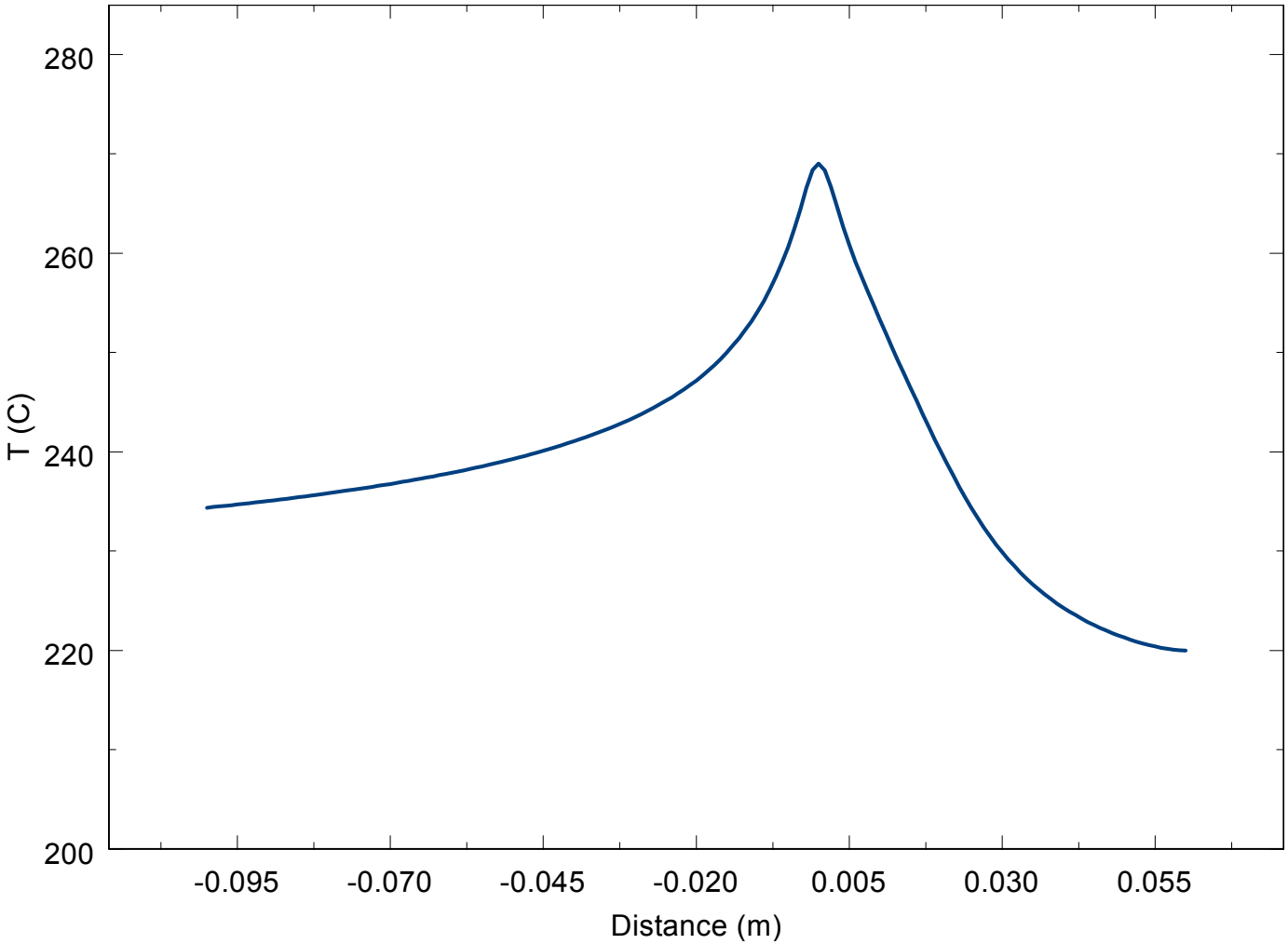
Low Power Case



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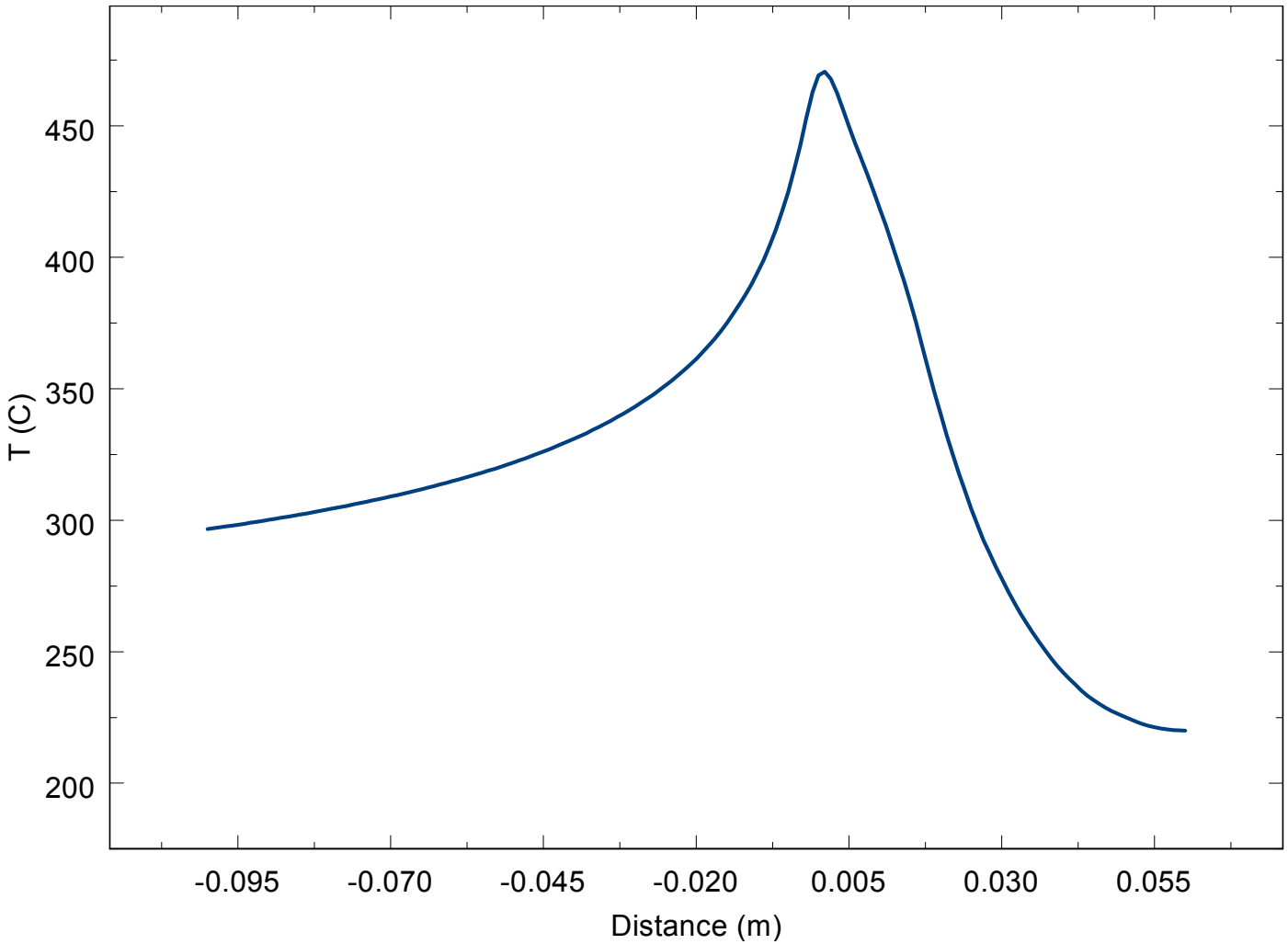
High Power Case



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PMI Concerns Discussed

- What will be the impact on NSTX operations?
  - How much power can be handled?
  - Will the particle containment time be altered? Will the limited area be ineffective?
  - Is NSTX just swapping a wall conditioning problem for equally or more difficult Li module problems?
  - Will high temperature required cause shifting of sensors or limiting surfaces?
  - How to condition Li surfaces?

Impact on Heating Systems

- Is the liquid surface module non-intrusive?
- Will high harmonic fast wave heating be altered? Impact on insulators needed for RF
- Will coaxial helicity injection still be feasible? Coating of the CHI insulator. How can the insulator be cleaned?
- How much more fueling will be required? >50 Torr l/s. Is pellet fueling required? Will gas fueling still be possible?
- Coating of windows, insulators, diagnostics?